Particle Therapy MasterClass

Yiota Foka (GSI/CERN)

on behalf of

IPPOG and IMC Steering Group

International Particle Physics Outreach Group

INTERNATIONAL MASTERCLASSES
hands on particle physics

PTMC in Puebla 2nd March 2020

https://youtu.be/pqx1Gj28GBE

THE First PTMC in IMC

physicsIMC
@physicsIMC

First International Masterclasses #physicsIMC on Hadron Therapy today! @UNAM_MX and @FISMATBUAP have invited 200 high school students to learn about the medical application of particle beams. Great new program under the umbrella of @IppogOrg

9:55 AM · Mar 2, 2020 · Twitter Web App

Puebla

Irais Bautista Guzman

PTMC session at BUAP-Puebla.

web page

https://www.fcfm.buap.mx/ParticulasElementales/seminarios/PT/index.html

Mexico City

Antonio Ortiz Velasquez

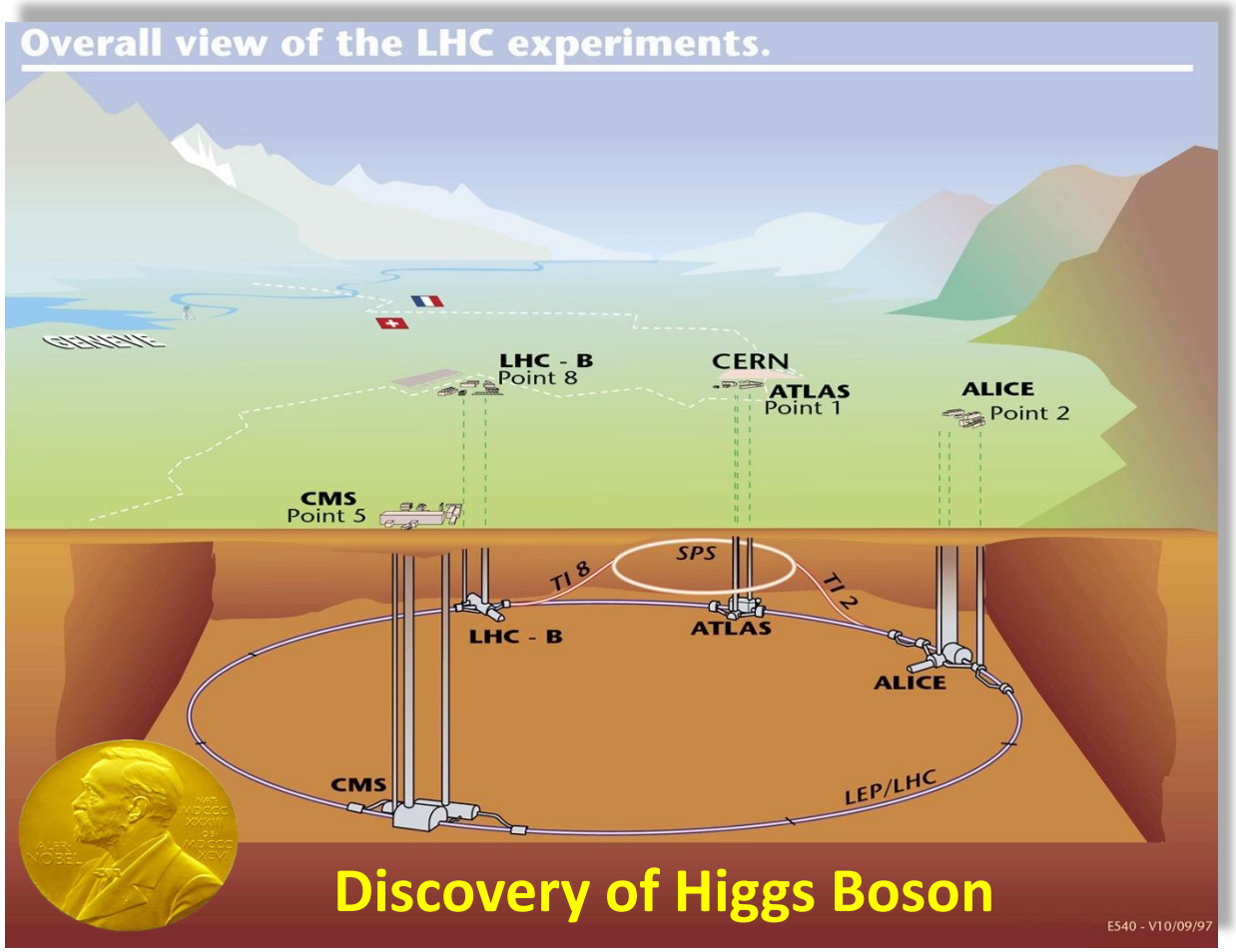
PTMC session in UNAM, Mexico City

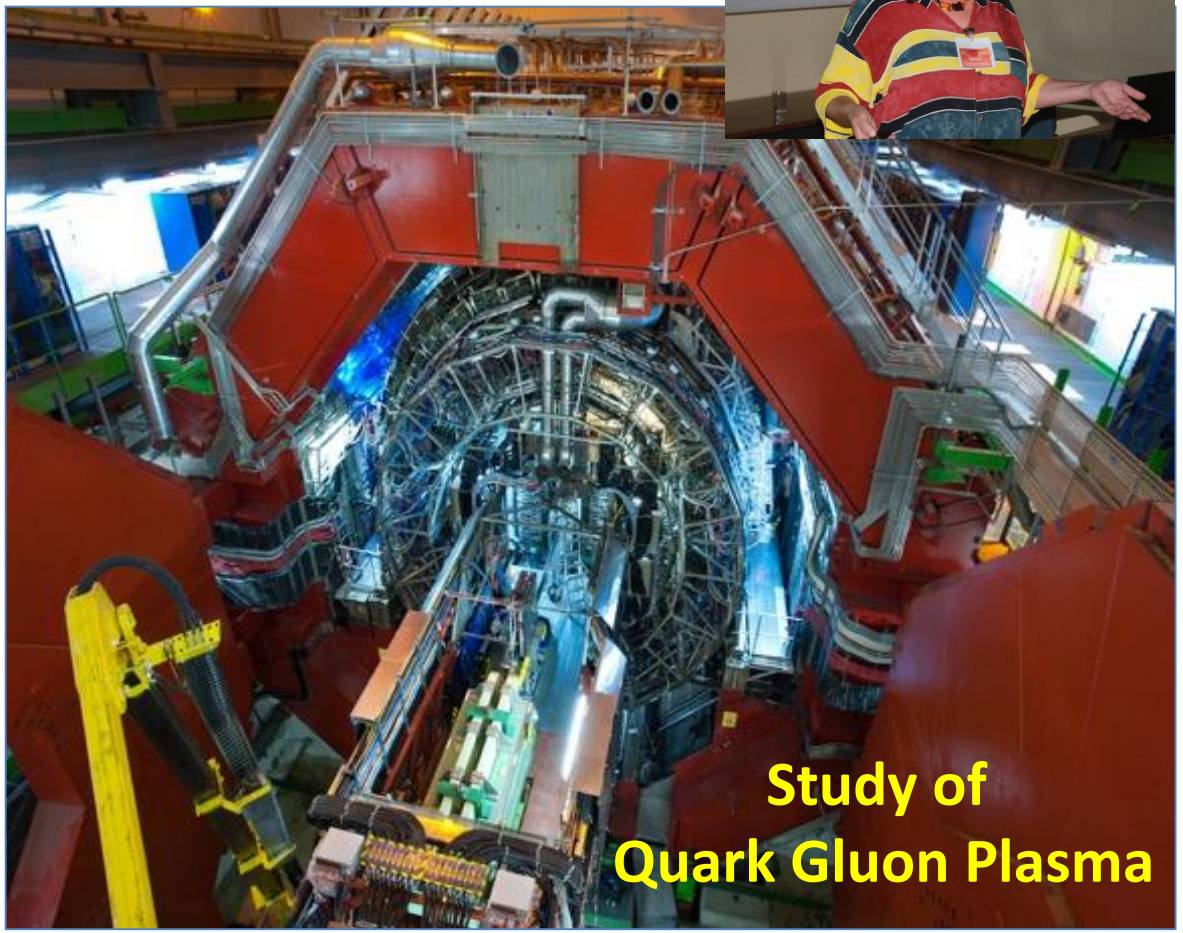
web page

http://epistemia.nucleares.unam.mx/web?name=fisica_y_sociedad_2020

Heavy-ion research and heavy-ion therapy

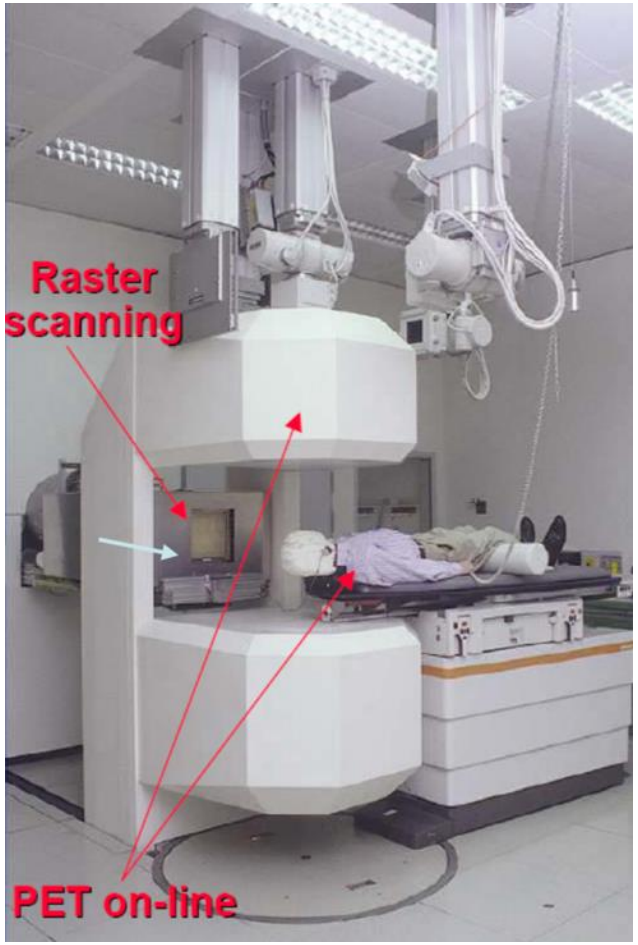
Heavy-ion Physicist,
involved with medical applications of heavy-ions for cancer therapy





Virtual visit: ALICE heavy-ion experiment at CERN.

Heavy-ion research and heavy-ion therapy at GSI



Pioneered heavy-ion (carbon) therapy for cancer tumours in Europe (90s).

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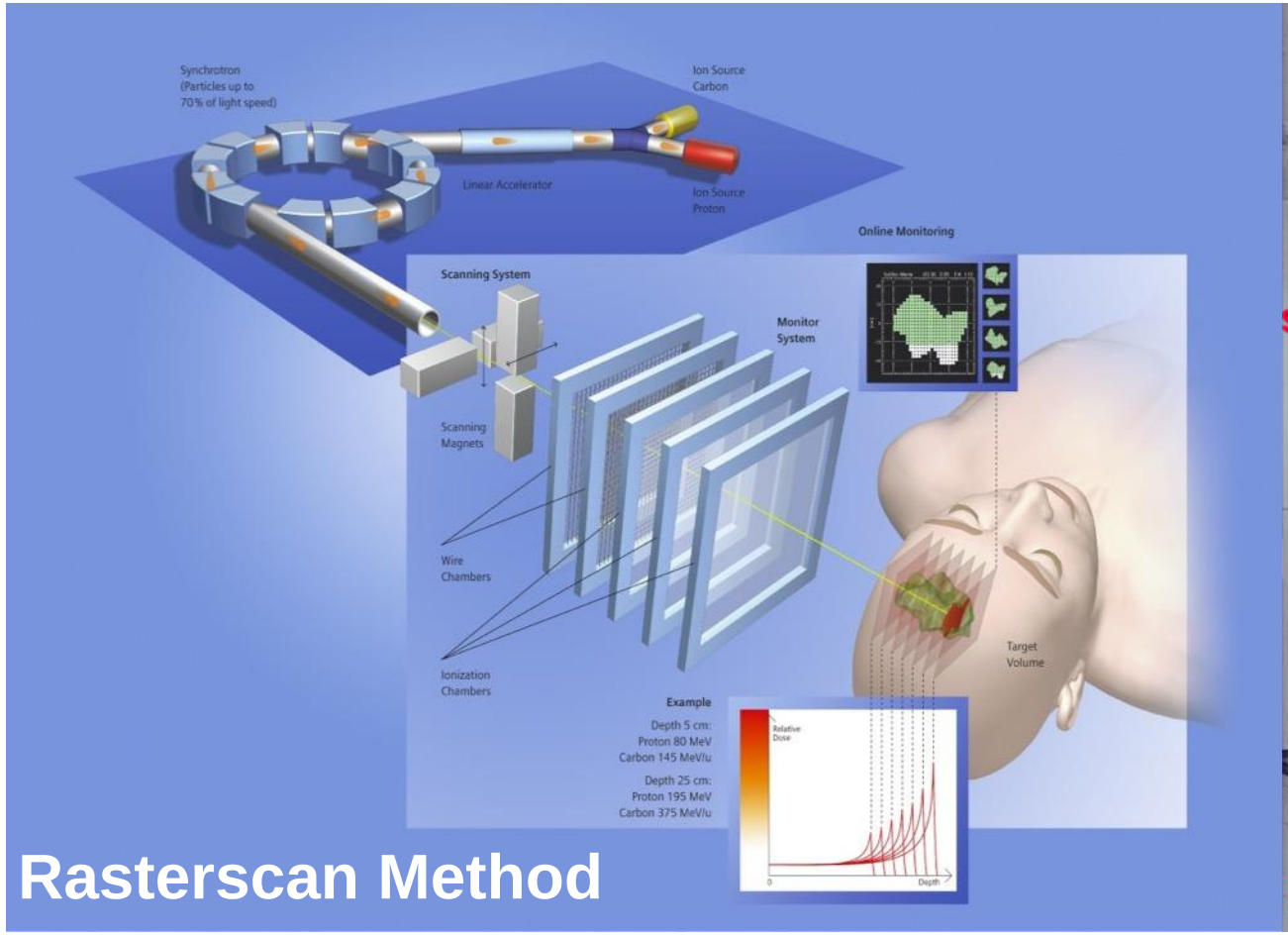
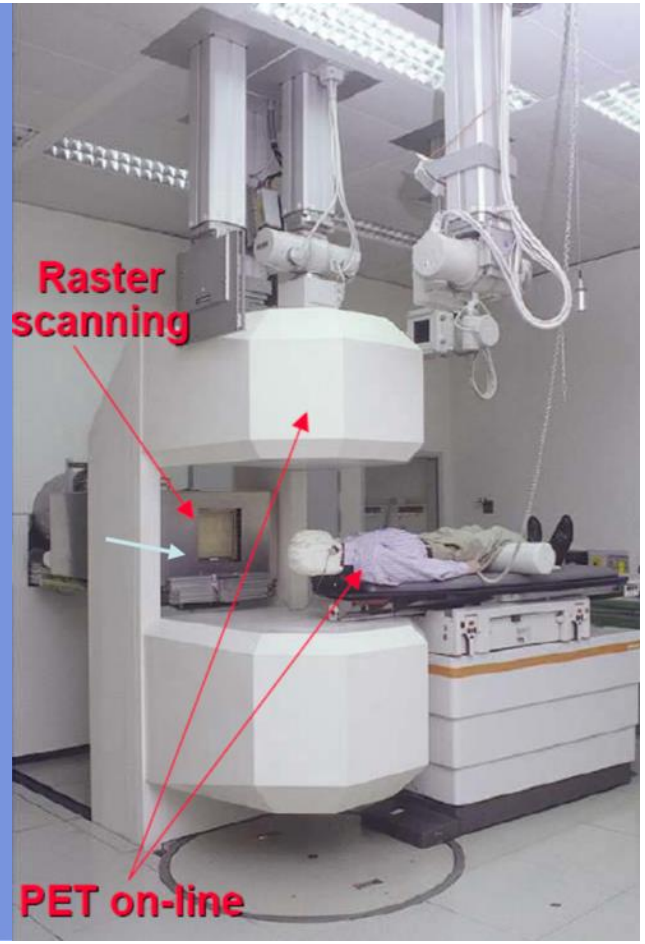
Heavy-ion research and heavy-ion therapy at GSI





Haberer et al., NIM A , 1993

Implemented in the Heidelberg and Marburg Ion Treatment centers (HIT and MIT) in Germany

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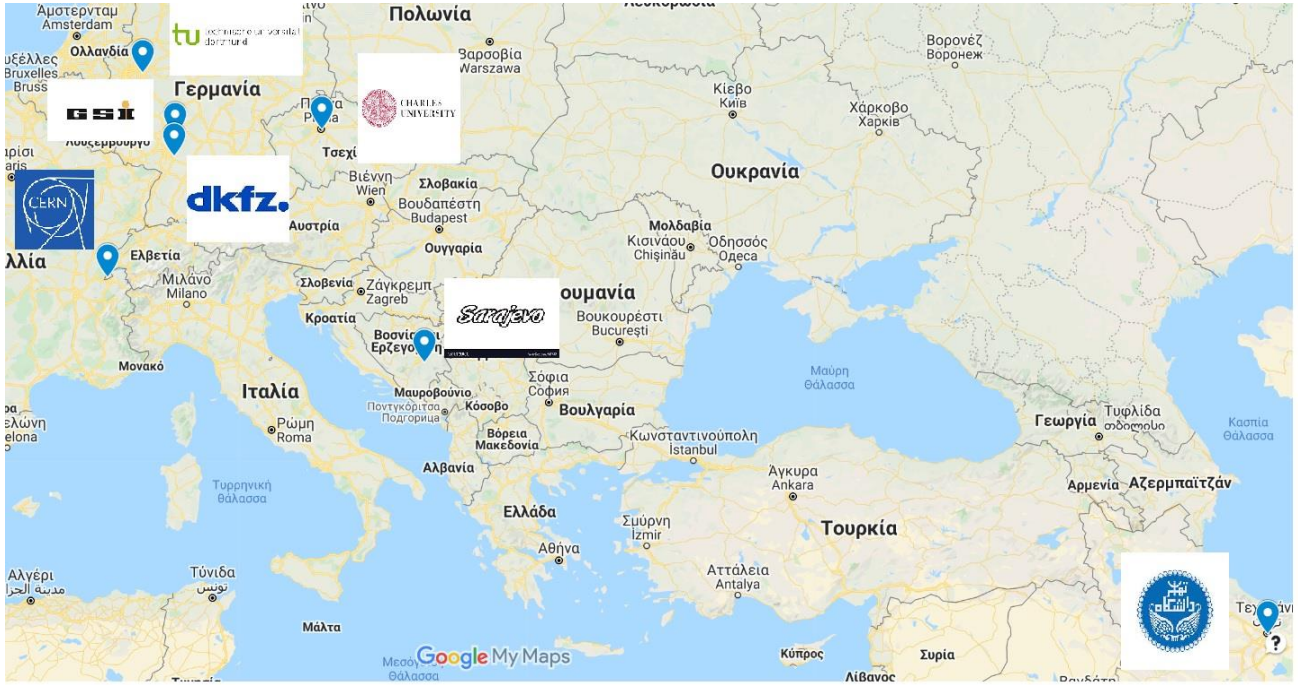
PTMC Participants, 10 and 11 March 2021

PTMC: https://indico.cern.ch/event/840212/



International MasterClasses https://physicsmasterclasses.org/

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https://physicsmasterclasses.org/

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Hands on Particle Physics Masterclasses

SCHEDULE 2021

At the end of each Masterclass day a videoconference between the institutes and with moderators at CERN, at Fermilab, TRIUMF, KEK, or GSI is established. The schedules for 2021 will be created early in 2021.

© CERN

© Fermilab

https://indico.cern.ch/event/840212/

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IMC Statistics 2019

Motivate the next generations of scientists !

54 countries

255 institutes

15 000 students

5 weeks in 2019

IMC 2021 :
11.2.2021 – 27.3.2021

Brings scientific methods and real data to schools!

Coordination QuarkNet / TU Dresden

- 51 institutes (48)
- 54 LHC Masterclasses (50)
  - 22 ATLAS (19)
  - 32 CMS (31)

  (Incl. TRIUMF program)
- 12 MINERvA Masterclasses

- 188 institutes (177)
- 266 LHC Masterclasses (257)
  - 30 ATLAS W (35)
  - 101 ATLAS Z (104)
  - 64 CMS (58)
  - 41 LHCb (39)
  - 27 ALICE SP (18)
  - 3 ALICE R_AA (3)

Flagship project of IPPOG, the International Particle Physics Outreach Group

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Concept and programme of an IMC day

Every year, during the months of
February-March
school-children (15-19 year old)
are invited to an institute of their area.

2-5 institutes per day performing the same programme

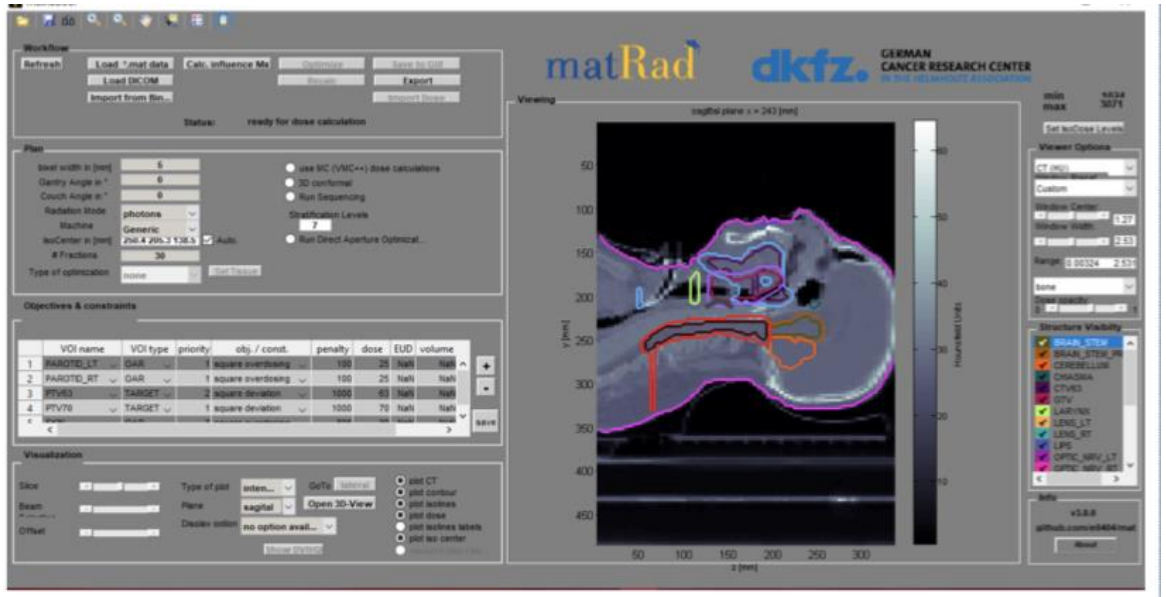
Scientists for a day !!

LOCAL TIME:	ACTIVITY
8:30 - 9:00	Registration and Welcome
9:00 - 10:00	Introductory lectures
10:30 - 11:30	Visit of a lab or experiment
12:00 - 13:00	Lunch
13:00 - 15:00	Hands-on session
15:00 - 16:00	Discuss results locally
16:00 - 17:00	**Video conference**

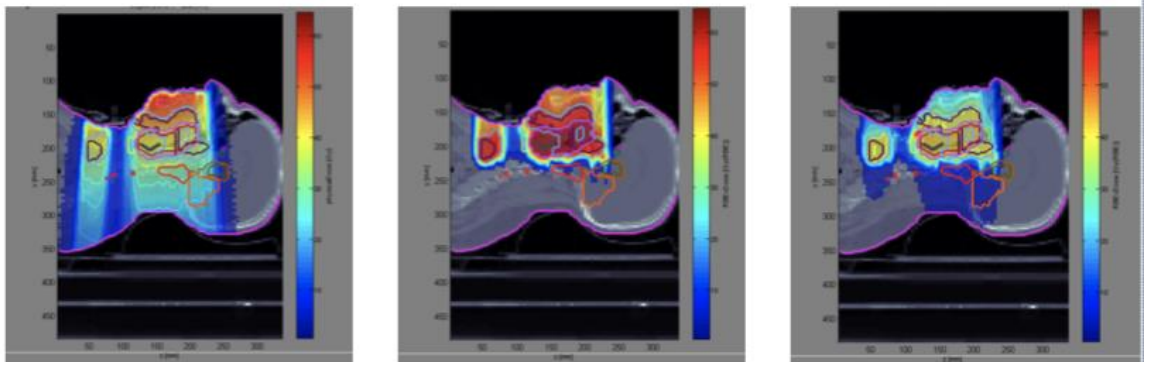
The aim is to get insight into topics and methods of research

New PTMC and Treatment Planning

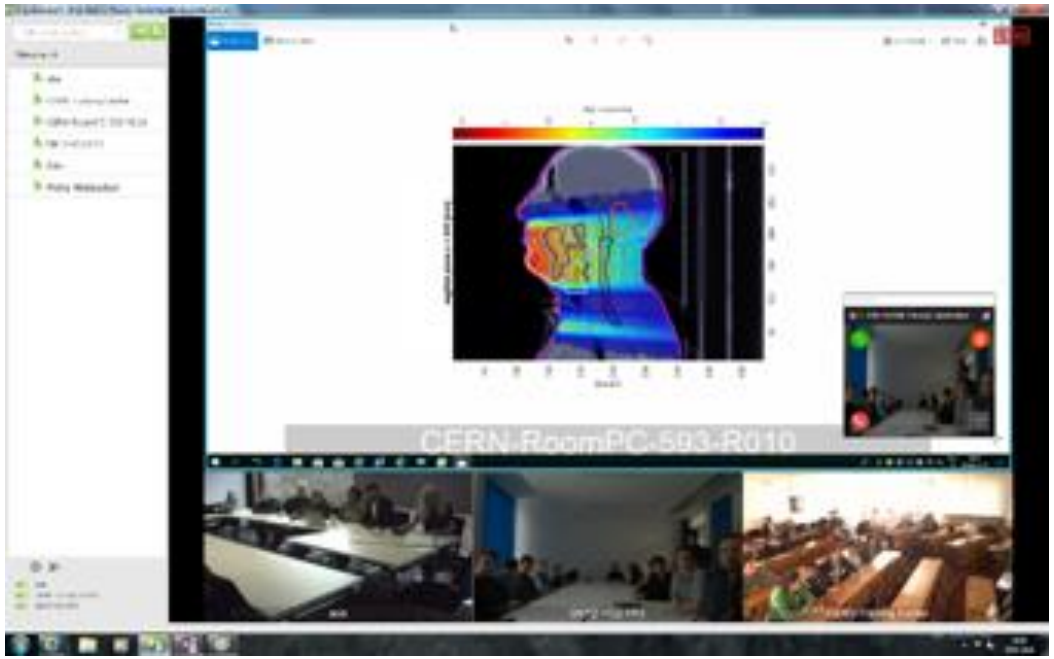
Based on professional open source treatment planning: matRad
developed by Heidelberg DKFZ www.matrad.org



Demo[4] of the matRad software kit for Treatment Planning .



Simplified version for PTMC
Using photons, protons and carbon ions



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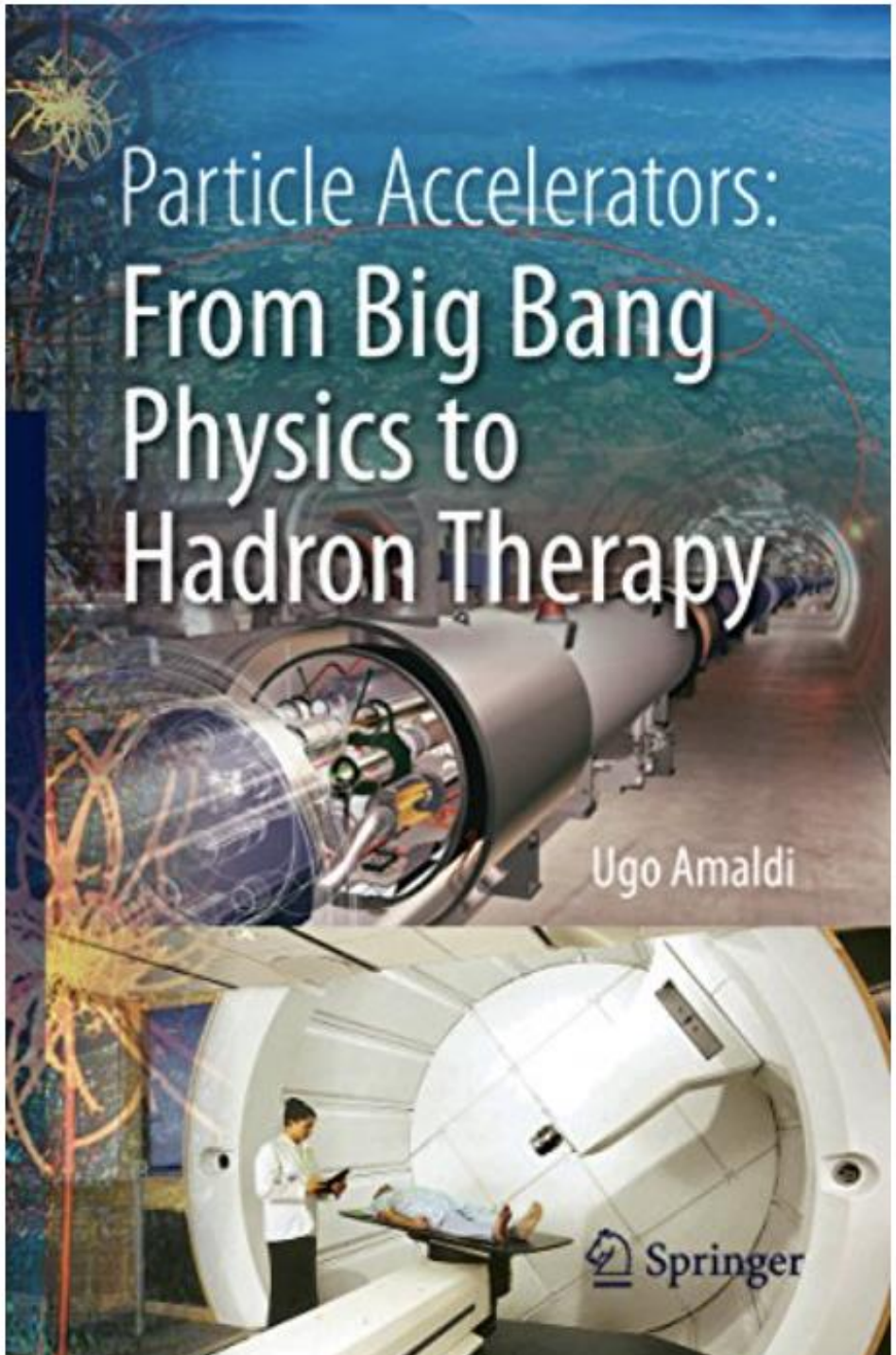

How is physics related to medicine?

What is particle therapy?

How one can use particles for cancer treatment?

Accelerators for research and accelerators for cancer treatment

One of the aims of PTMC: address such questions

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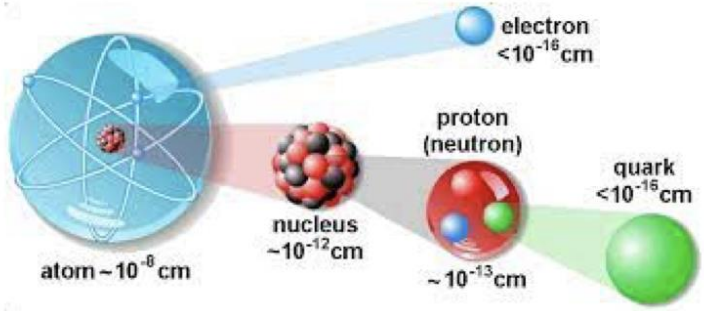
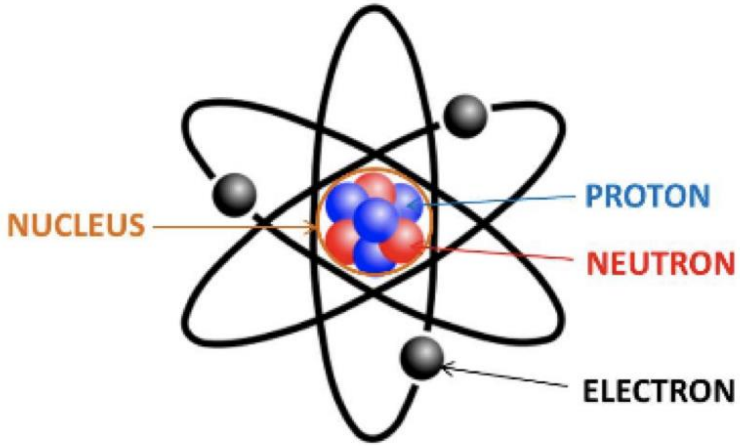
Accelerators: our key to the subatomic world

Where do we find the particles?

Inside the atoms!





We can use electrons (very light) or protons (1836 times heavier).

Particle therapy = Hadron therapy:
proton therapy, carbon ion therapy, ion therapy

Particle accelerators are our door to access the subatomic dimension… and exploit the atom and its components

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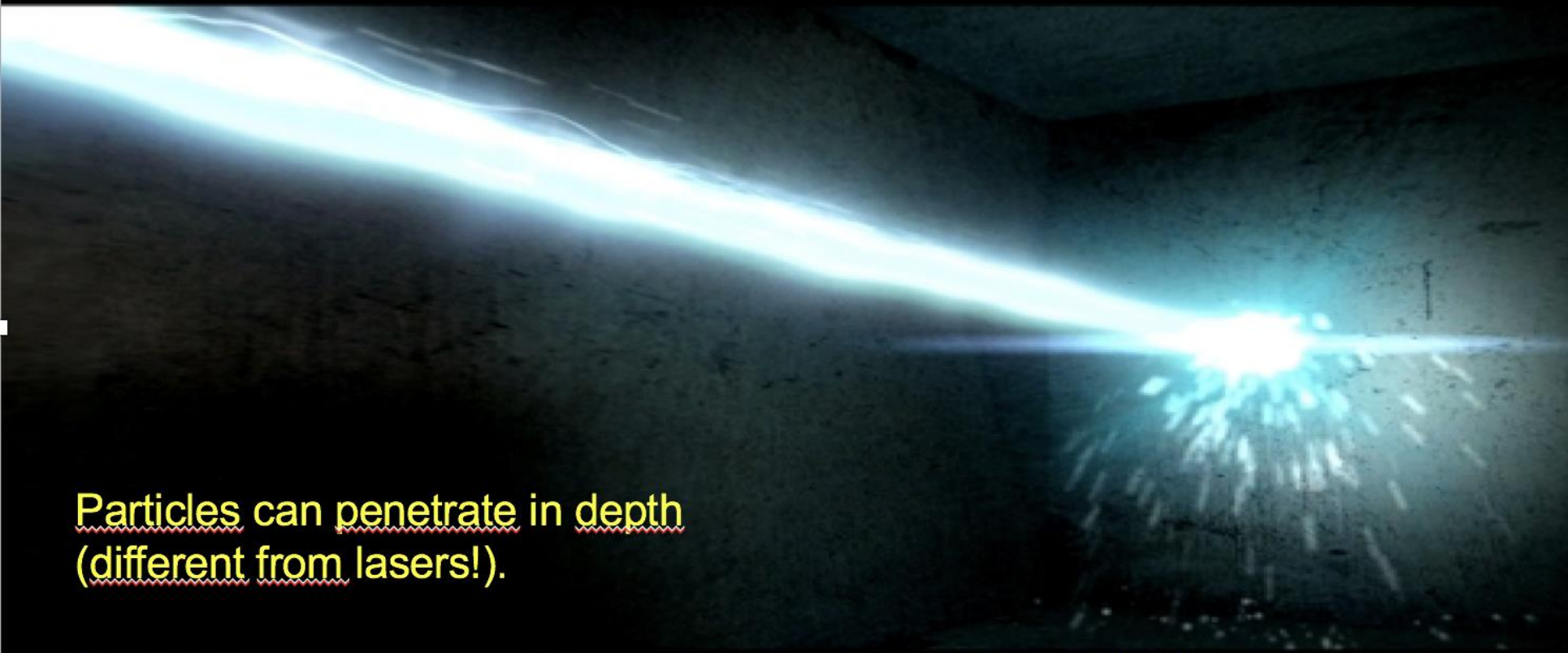
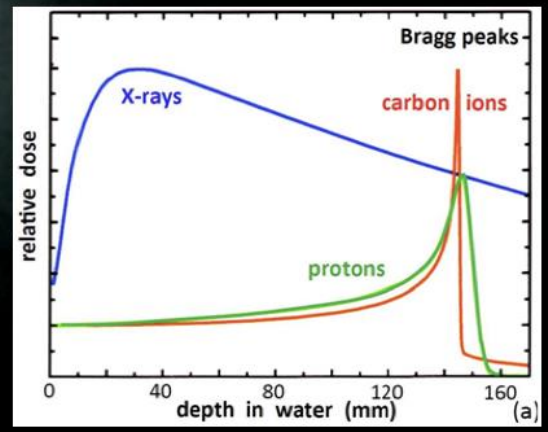
Accelerators: can precisely deliver energy

A «beam» of accelerated particles is like a small “knife” penetrating into the matter



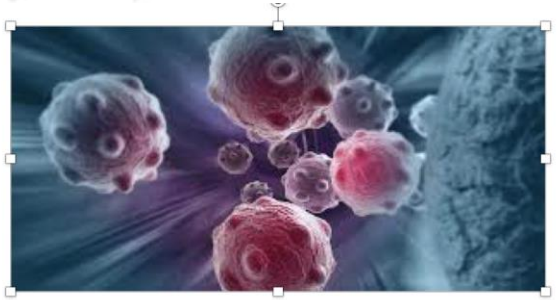
A particle beam can deliver energy to a very precisely defined area, interacting with the electrons and with the nucleus.

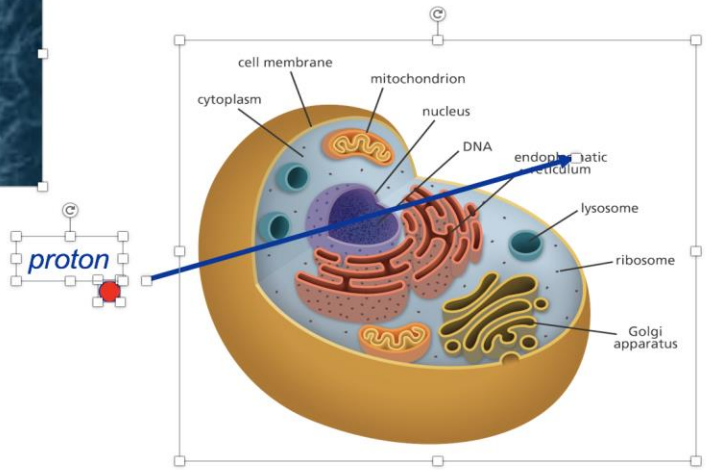


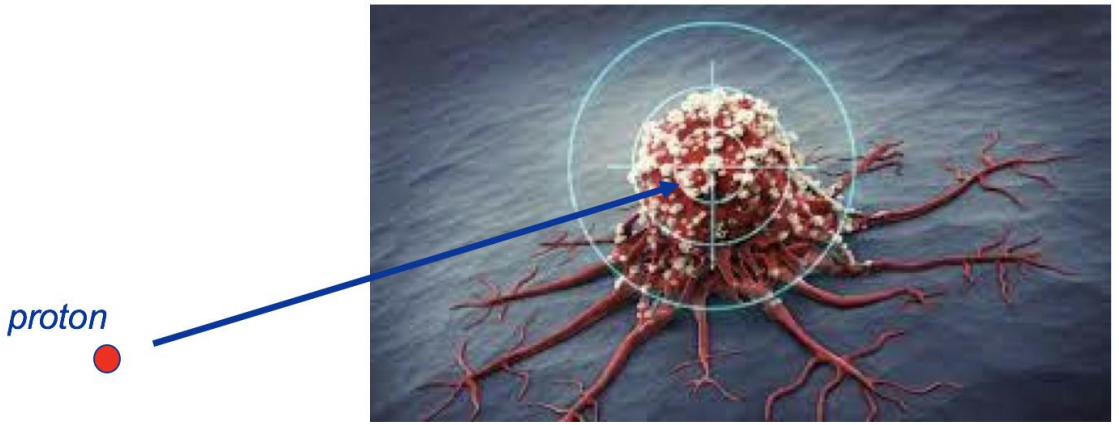
Particles can penetrate in depth (different from lasers!).

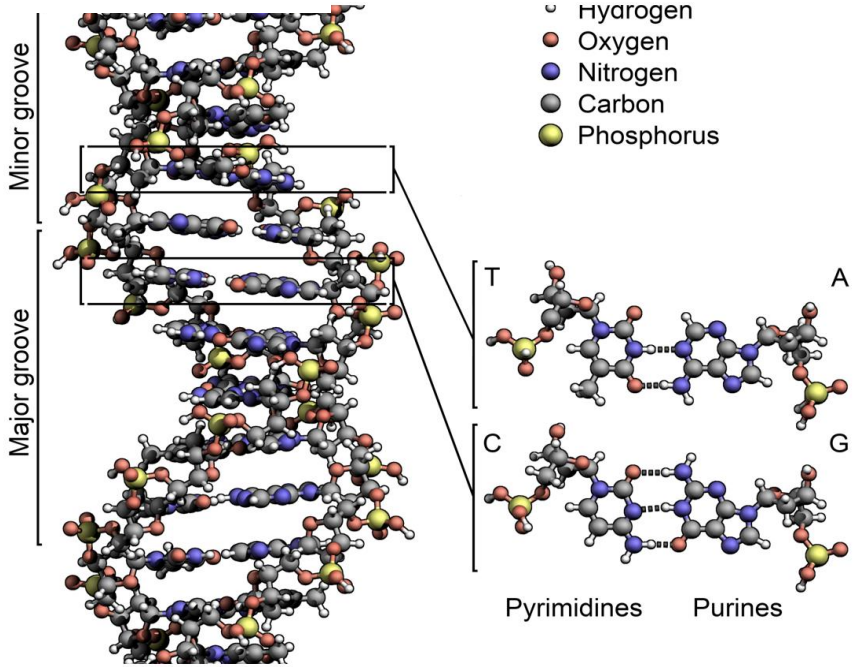
Particle beams are used in medical and industrial applications, e.g. to cure cancer, delivering their energy at a well-defined depth inside the body (Bragg peak)

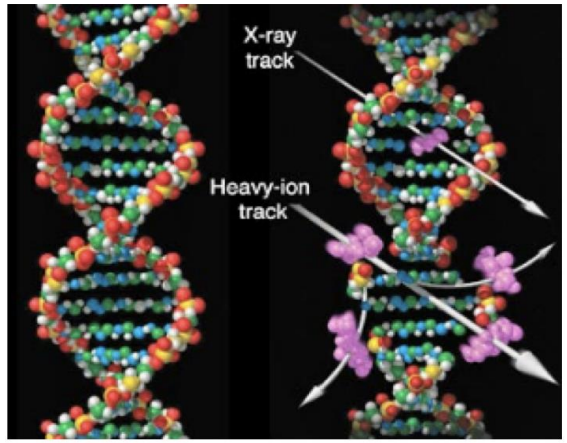
A particle beam can break the DNA and kill a cell











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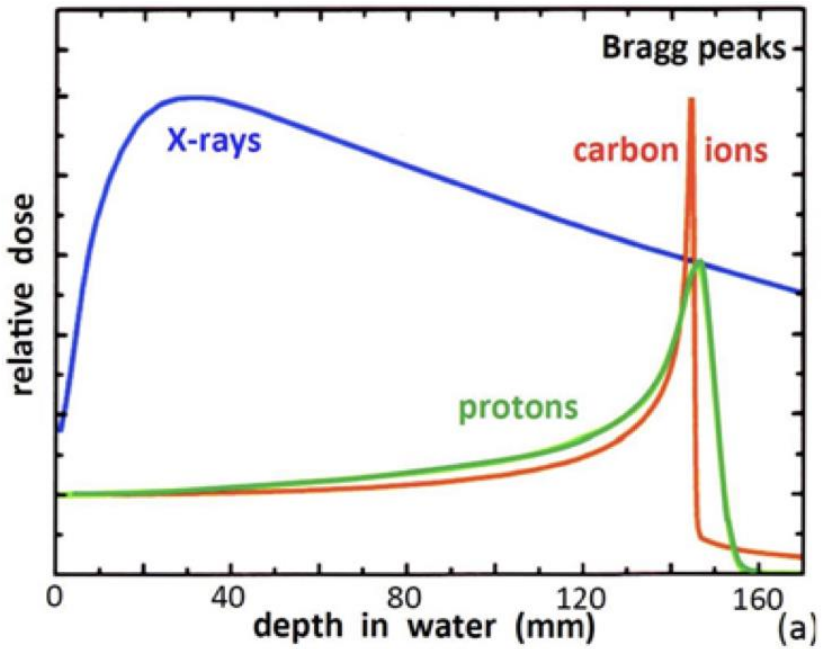
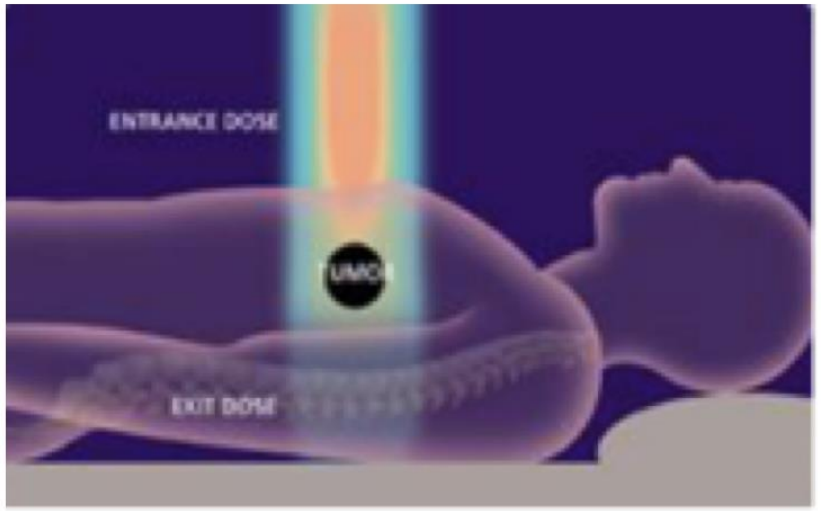
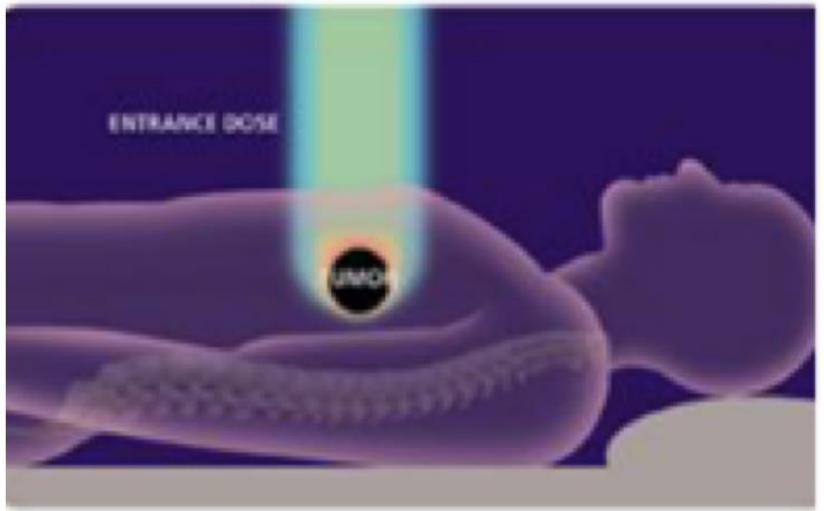
Hadron therapy with protons or ions

The Bragg peak







Different from X-rays or electrons, protons (and ions) deposit their energy at a given depth inside the tissues, **minimising dose to the organs close to the tumour,** sparing nearby organs.

Required energy for full-body penetration: 230 MeV protons, 450 MeV/u C-ions.

22,000 patients/year (2018) treated with particle beams, 25,000,000 patients/year with X-rays.

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Accelerator and Society

Over 30'000 particle accelerators are in operation world-wide.

Only ~1% are used for fundamental research.

Medicine is the largest application with more than 1/3 of all accelerators.

Research		**6%**
	Particle Physics	0,5%
	Nuclear Physics, solid state, materials	0,2 - 0,9%
	Biology	5%
Medical Applications		**35%**
	Diagnostics/treatment with X-ray or electrons	33%
	Radio-isotope production	2%
	Proton or ion treatment	0,1%
Industrial Applications		**<60%**
	Ion implantation	34%
	Cutting and welding with electron beams	16%
	Polymerization	7%
	Neutron testing	3.5%
	Non destructive testing	2,3%

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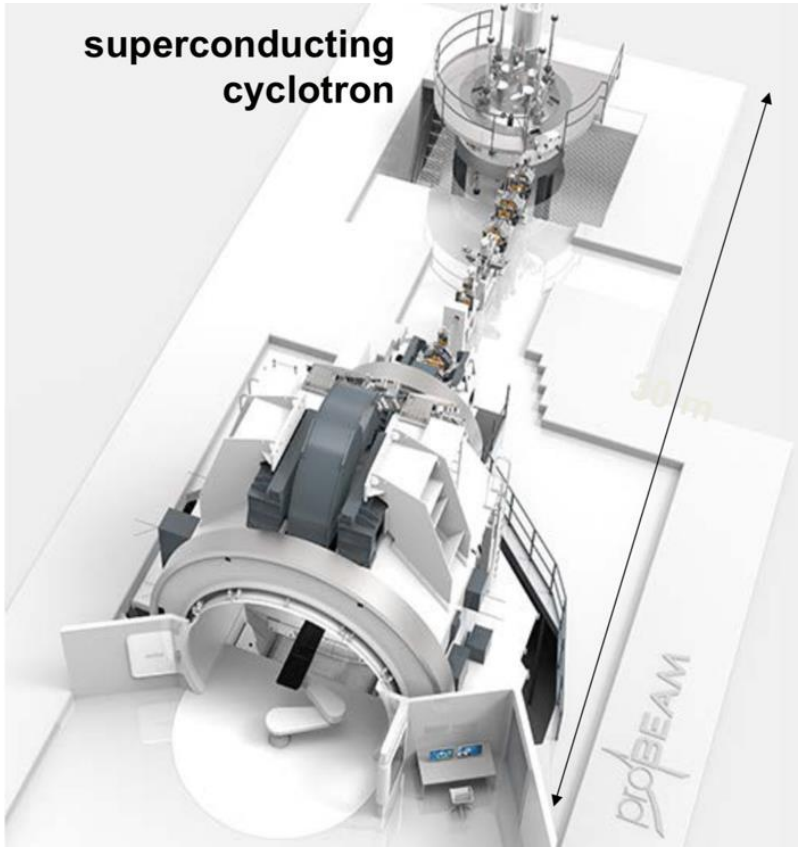
Accelerators for health

Conventional x-ray Radiotherapy

Particle/Hadron Therapy with protons



Hadron Therapy centers in Europe (2018)

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Four carbon-ion cancer therapy centers in Europe

CNAO, Italy

HIT, Germany

MIT, Germany

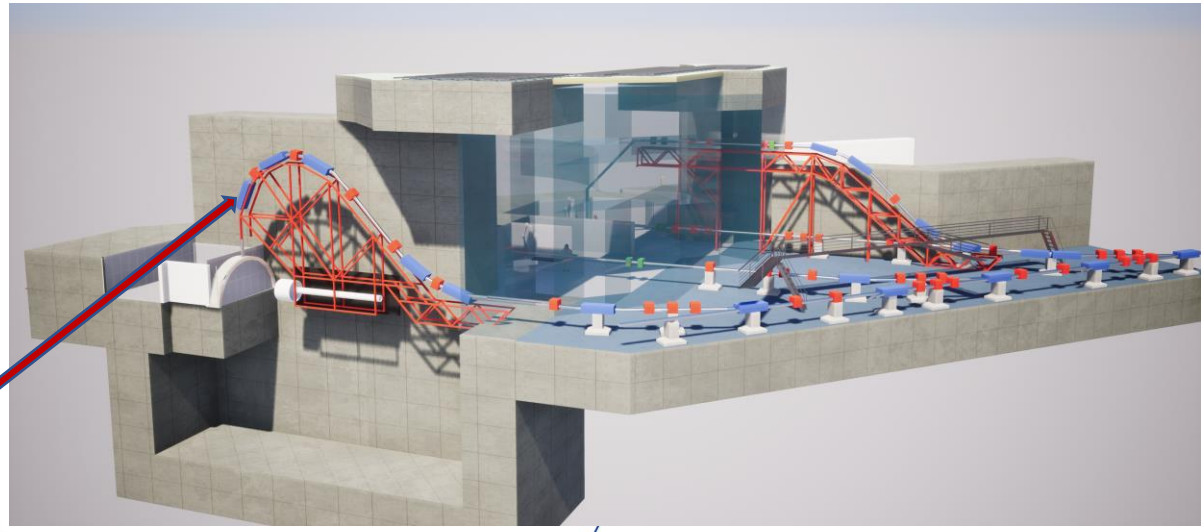
MedAustron, Austria

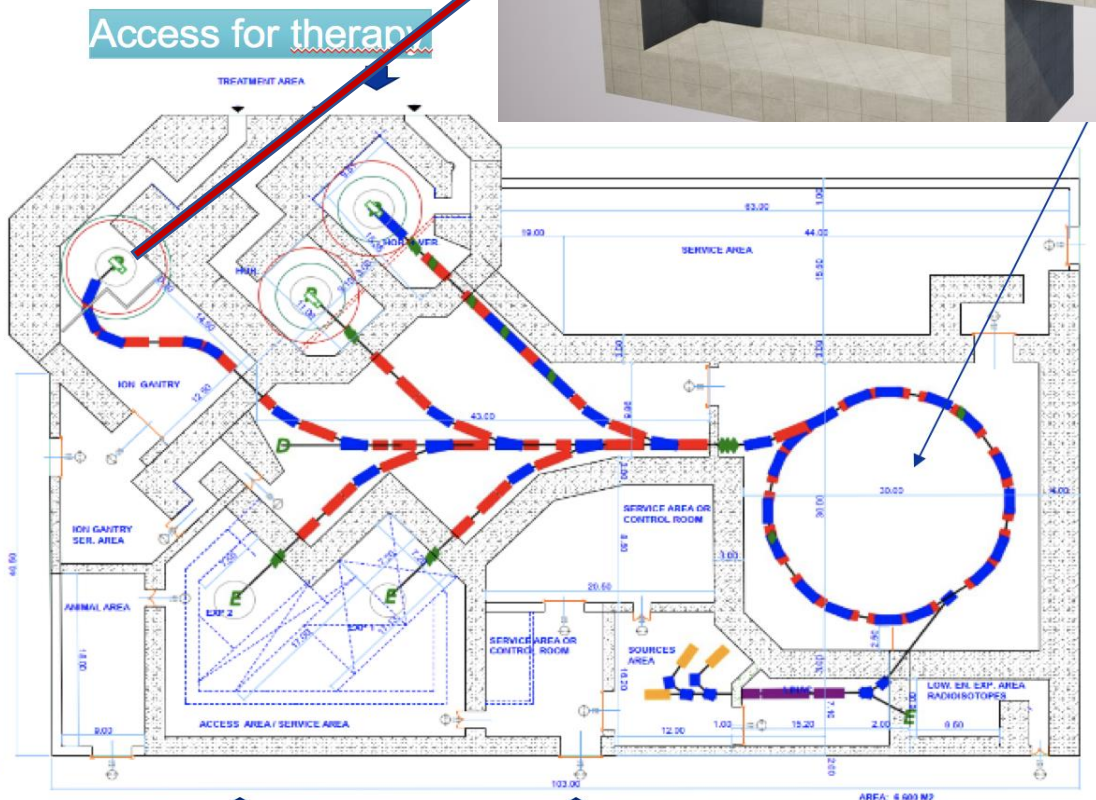
Virtual Hadron Therapy Center

Accelerator and Beam Delivery

Gantry at HIT 600 tons

40 tons Gantry at SEEIIST





SEEIIST facility

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Next generation facility for cancer tumour therapy and research with heavy-ion beams

Basic concepts for a

SOUTH-EAST EUROPE INTERNATIONAL INSTITUTE FOR SUSTAINABLE TECHNOLOGIES (SEEIIST)

January 15, 2018

Proposal for a facility in South East Europe: SEEIIST

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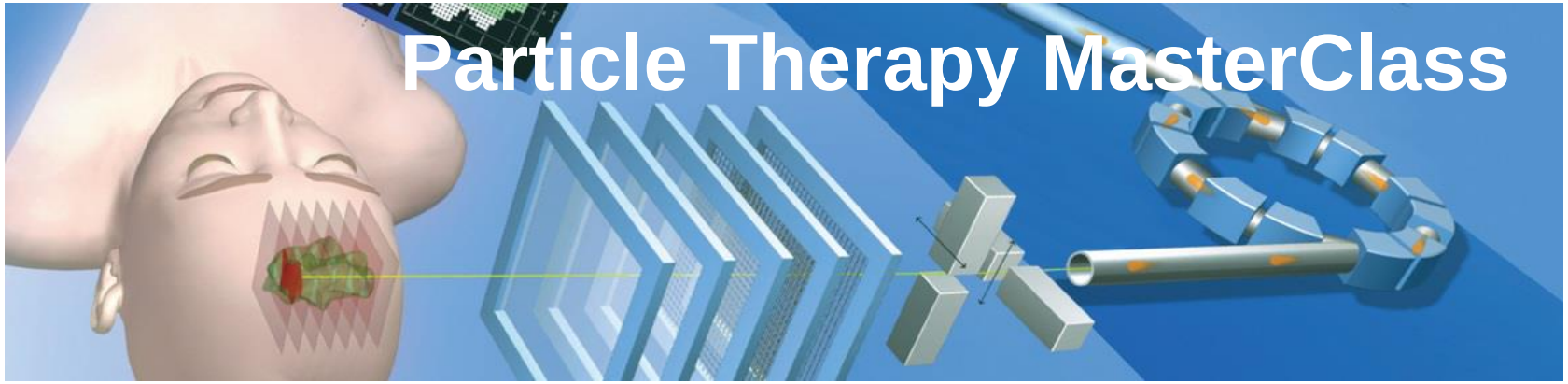
Particle Therapy MasterClass



- Home
- Posters
- Aim
- Materials
- Agenda
- Instructions
- Invitation
- Survey
- Articles
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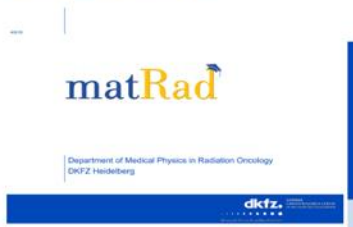
Contact

pt.mc@cern.ch

Presentations

https://indico.cern.ch/event/840212/

Presentation of MatRad

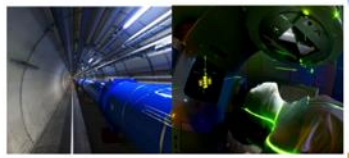


Particle Therapy Masterclass

Overview and Pilot Report

For ppt click here.

Presentation of Particle physics to medical applications



Manjit Dosanjh, CERN

Introductory presentation in Greek

Workflow Instructions

Workflow Instrukcije

Material in different languages including animations and recordings

And in Spanish

https://drive.google.com/drive/folders/1L94yhos6L7k3FQlMzD9Ql7kpk_c_ABD7

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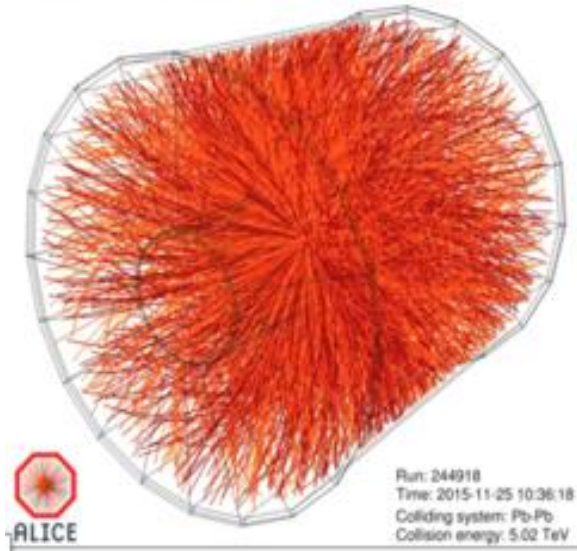
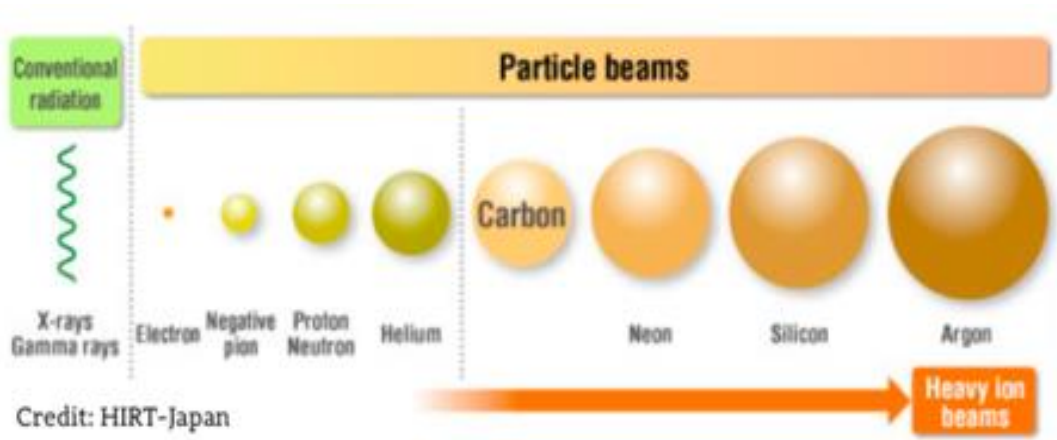
Heavy-ion research and heavy-ion therapy

Pb-Pb at 5.5 TeV
pp at 14 TeV

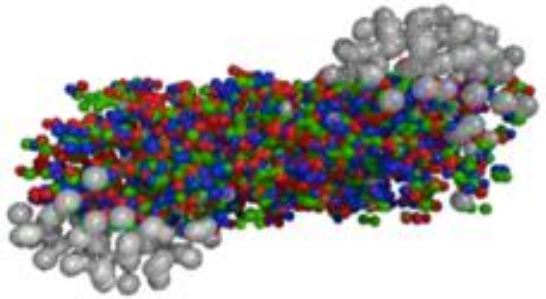
fundamental science
QGP studies

Credit: CERN





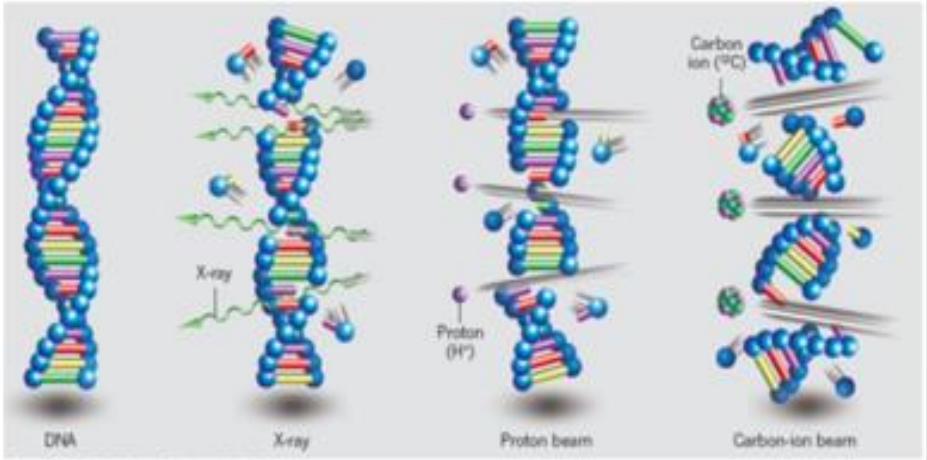
Credit: HIRT-Japan



88-430 MeV/u carbon
50-221 MeV/u protons

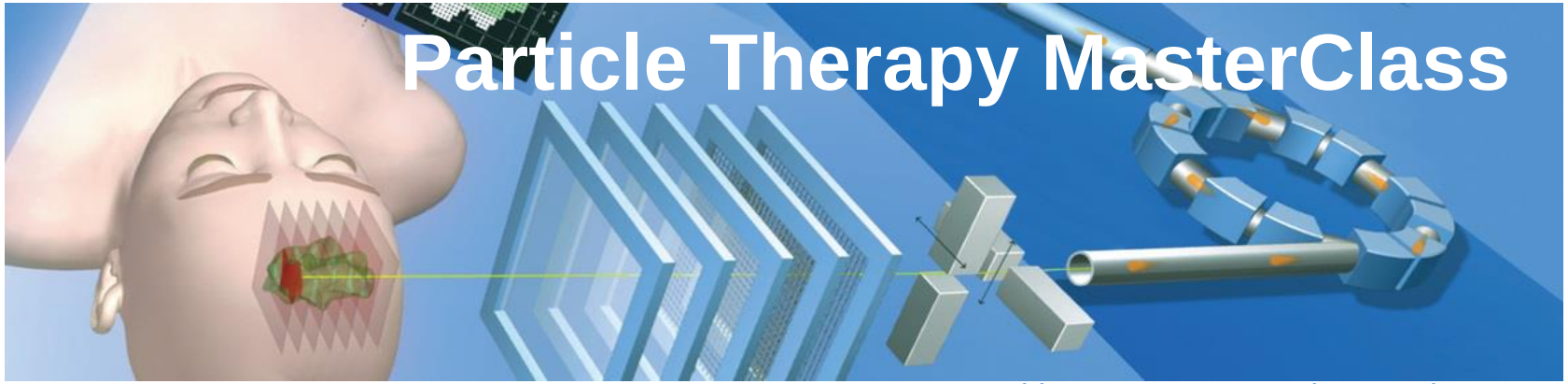
applied science
medicine

Credit: HIT Heidelberg



Credit: T. Nomiya, NIRS Japan

Particle Therapy MasterClass



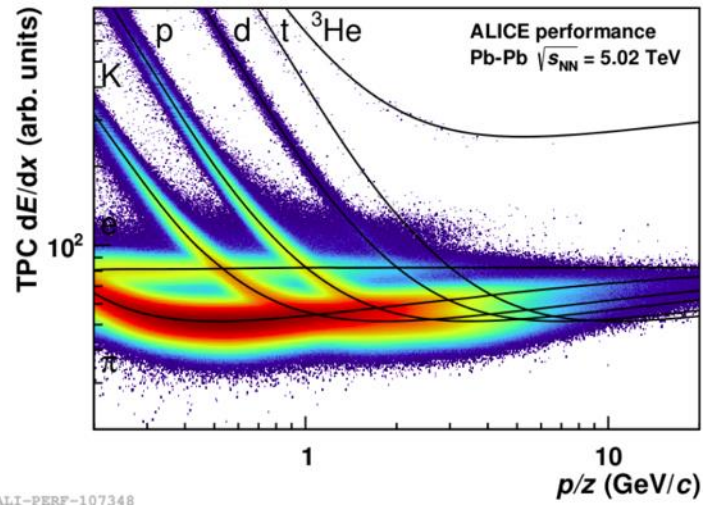
https://indico.cern.ch/event/840212/

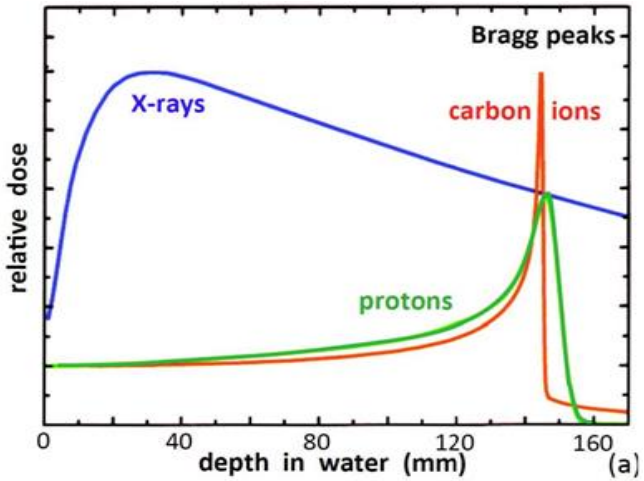
Aim: benefits for society from fundamental research

Direct applications for health of instrumentation and methods
developed for fundamental research: accelerators, detectors, software....

Aim: enhance awareness on HT cancer therapy possibilities

From Bethe Bloch ionization for PID to Bragg peak for cancer therapy





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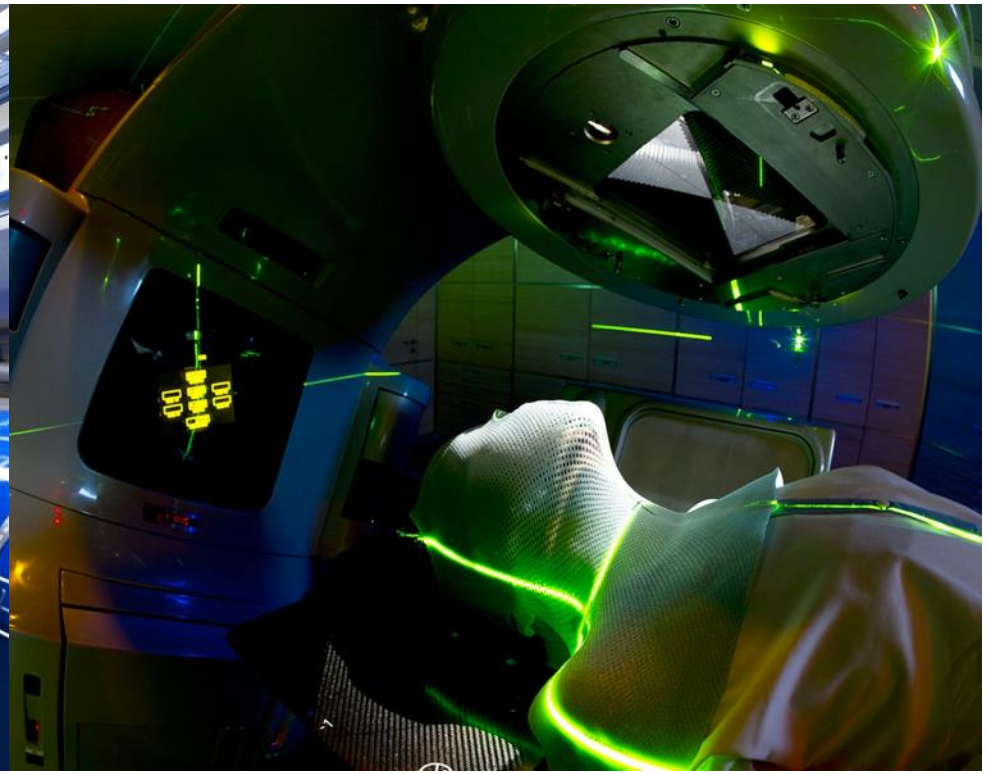
Accelerators for health

From fundamental research…



……to medical applications

Video-visit: CNAO heavy-ion therapy center

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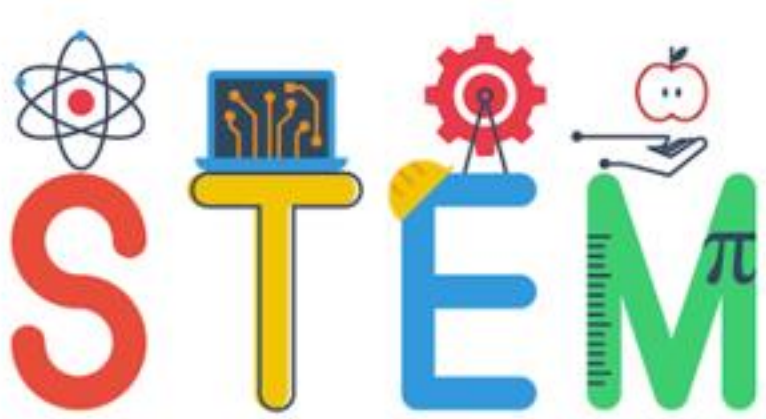
From participants to collaborators

Attendees of IMC were attracted by Science, Technology, Engineering and Math careers.
It was definitely our case



It is inspiring to young students.

This could mean more professionals in STEM topics

Noteworthy fact:
now we collaborate in UNAM with our MC tutor Antonio Ortiz Velasquez

.

https://indico.cern.ch/event/840212/